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CONTRIBUTION OF BLUE-GREEN ALGAE ON FERTILITY OF RICE SOIL FERTILIZED WITH NPKSZn

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NPKSZn fertilizers applied in rice field decidedly improved the efficacy of N-fixation by *Nostoc, Anabaena, Aulosira, Calothrix, Nodularia* and *Hapalosiphon*. The efficiency was appreciably better in plot receiving no N. Soil fertility also improved through accumulation of biomass by blue-green algae. About 8.5% more total N was recorded in PKSZn treated plot than control. This possibly explains the fact that added PKSZn stimulated N-fixation in rice field. However, the extent of N-fixation decreased in N-treated plot. Amount of (NO2 + NO3)-N, NH4-N and C:N ratio was significantly improved by PKSZn treatment.

Keywords : Biomass; C:N ratio; N-fixation; NPKSZn fertilizers; Soil fertility.

Introduction

Soil fertility is one of the important factor of the maximization of crop yield. However, now-a-days, it has been well recognized that soil fertility is going to be depleted due to intensive farming. This phenomenon is quite common and is getting momentum to the agriculturist to maintain the fertility and ecosystem of the soil, particularly in rice field. Use of HYV rice in modern cultivation leads to the shortage of some essential elements like N, P, S and Zn which have recently been considered as yield limiting factors. Authors are in opinion that continuous application of synthetic fertilizers viz. urea has been causing a many-fold problems for the rice field ecosystem, which could be significantly over come by introduction of biofertilizers[1-3].

Recently, it has been approached that culture of blue-green algae BGA in rice field promotes the accumulation of biomass[2-3] which could prevent the fertility status from irreversible loss. With an advanced idea, some authors proposed that incorporation of TSP, gypsum and essential elements could achieve quite a favourable ecosystem for N-fixation in rice soil[4-5].

In view of the above, a study was designed to assess the contribution of BGA on soil fertility under rice (BR11) cultivation fertilized with NPKSZn.

Materials and Methods

A field experiment was conducted at BRRI farm in Gazipur District with BR11 variety of rice during Boro season. N, P, K, S and Zn were applied at the rate of 120, 26, 33, 30 and 5 kg/ha as urea, TSP, MP, gypsum and $ZnSO_4$. Twelve treatments (control, N, NK, NP, NPK, NPKZn, NPKS, NSZn, PKSZn, NKSZn, NPSZn, NPKSZn) were arranged following a randomizd block design with four replications.

Soil samples were collected for algal enumeration (0-5 cm) and soil fertiltiy assessment (0-15 cm). One composite sample comprised four sub-samples of each plot was collected squarely. Quantitative enumeration of BGA was done in Fogg's medium[6] following MPN method[7] using a probability table[8]. The cyanobacterial forms were identified by standard method[9-10].

Soil sampless collected for fertility evaluation were air-dried and powdered to 100 mesh. Estimations were done for organic carbon[11], available N[12] and total N by Kjeldahl distillation method. Organic matter and C : N ratio were calculated by multiplying percentage of organic carbon by the recovery factor, 1.724 and dividing by percentage of toal N respectively.

Results and Discussion

Rice soil analyses showed the presence of both nonheterocystous and heterocystus blue-green algae. The most potential nitrogen fixers were *Nostoc, Anabaena, Aulosira, Calothrix and Hapalosiphon*. Plot treated with 120 kg N/ha revealed the presence of

Nostoc and *Aulosira* species. Contrary to this, the abundance of *Nostoc, Anabaena, Microchaete, Scytonema* and *Calothrix* was osberved in plot receiving no fertilizers. However, in PKSZn treated plots, the commom heterocystous species of BGA were *Nostoc, Anabaena, Nodularia, Calothrix and Hapalosiphon*.

Quantitatively the results also demonstrated that plots provided with no fertilizer showed poor growth of indigenous BGA. These findings are in good conformity with the previous observations of Roger and Kulasooriya[3] particularly in rice growing soil. It could be seen that before transplanting rice in the plots, a significant variation in indigenous algal population was observed ranging from 20 x 10^4 to 131.7 x 10^4/g soil. This apparent variation may be resolved by the fact that the experimental field was under the same treatments for last several years. So, the initial variation in indigenous algal population is quite conceivable.

From Table 1, it is apparent that the highest amount of organic carbon (1.69%) was in PKSZn and NPK treated plots before and after harvesting respectively. Similarly, the lowest values (1.08 and 1.20%) were recorded in control and NK treated plots during initial and harvesting stages of rice. Variation in organic matter followed the same sequence as in organic carbon (Table 1).

Content of (NO_2 + NO_3)-N varied significantly among the treated plots (Table 1). Generally higher amount of (NO_2 + NO_3)-N was observed in NP, NK, NPK, NKSZn, NPSZn and NPKSZn treated plots. However, the highest amount (188.65 mg/100 g) was recorded in control before transplanting rice. The picture pattern in the same was different after transplanting the crop.

As regard to NH_4-N before transplanting it was same (34.30 mg/100 g) in N, NP, NPKSZn treated plots together with the control (Table 1). Contrary to this, the values in rest of the treated plots remained between 10.29 and 17.15 mg/100 g soil. Almost a similar trend was osberved in content of NH_4-N after harvesting of rice. Amount of NH_4-N determined remained within the range of 10.29 to 34.30 mg/100 g soil.

Content of available nitrogen [(NH_4+NO_2 + NO_3) -N] also varied significantly showing an almost similar trend like (NO_2 + NO_3)-N (Table 1). The highest content of available N was found in control (223.0 mg/100 g) and NK treated plots (92.6 mg/100 g) before transplanting and after harvesting respectively. These amounts lowered down to 54.9 and 34.3 mg/100 g soils under identical conditions of soil in NPKS and N supplemented plots respectively. It was found that available N content was generally lower after harvesting of the crop which is quite obvious.

Total amount of nitrogen in NPKSZn treated plots varied non significantly before transplanting and significantly after harvesting of the crop (Table 1) from 1.41 to 1.82 and 1.23 to 1.54% respectively. The highest and lowest values before transplanting were recorded in N and NPKZn treatments. However, after harvesting of rice the lowest value of N was also observed in only N treated plot. In contrast, the highest value (1.54%) was encountered in NPK, NPSZn and NPKSZn provided plots.

Total N content (1.72%) in plot receiving all the fertilizers except N and in control was very close to the highest value (1.82%) and was more than those of most of the treatments before transplanting of rice. It is interesting to note that the amount of N measured after harvesting was higher (1.41%) in PKSZn treated plot than that of control (1.30%). This possibly suggests that N-fixation had been occurred and favoured by the presence of PKSZn. The amount of N recorded in this plot was higher than other treatments receiving N-fertilizer too. This further supports that N-fixation through BGA was more in plot devoid of added N. The contribution of interaction of PKSZn fertilizers could possibly help to stimulate the fixation of N by BGA particularly by the heterocystous ones. Similar views also expressed by other investigators too[3,13].

Table 1. Effects of NPKSZn and BGA on fertility of rice growing soil.

Treatments	BGA/g soil x 10^4	Organic carbon (%)		Organic matter (%)		$(NO_2 + NO_3)$-N (mg/100 g soil)		NH_4-N (mg/100 g soil)		Available N (mg/100 g soil)		Total N (%)		C : N ratio	
		BT	AH	BT	AH	BT	AH	BT	AH	BT	AH	BT	AH	BT	AH
Control	20.0	1.08	1.20	1.34	2.07	188.65	20.58	34.30	10.29	223.0	30.9	1.72	1.30	0.63	0.92
N	20.0	1.33	1.57	2.29	2.71	41.16	20.58	34.30	13.72	75.5	34.3	1.41	1.23	0.94	1.28
NK	35.0	1.25	1.20	2.16	2.07	120.05	58.31	10.29	34.30	130.3	92.6	1.58	1.23	0.79	0.98
NP	43.3	1.45	1.49	2.49	2.57	137.20	20.58	34.30	34.30	171.5	54.9	1.61	1.44	0.90	1.03
NPK	56.7	1.16	1.67	1.99	2.91	150.92	27.44	13.72	10.29	164.6	37.7	1.58	1.54	0.73	1.10
NSZn	35.0	1.41	1.45	2.43	2.50	89.18	34.30	10.29	34.30	99.5	68.6	1.61	1.37	0.88	1.06
NPKZn	68.3	1.45	1.29	2.50	2.22	113.19	30.87	10.29	13.72	123.5	44.6	1.82	1.31	0.80	1.07
NPKS	85.0	1.65	1.37	2.84	2.36	41.16	42.53	13.72	13.72	54.9	56.3	1.65	1.37	1.00	1.00
PKSZn	20.0	1.69	1.65	2.91	2.84	54.88	42.53	10.29	13.72	65.2	56.3	1.72	1.41	0.98	1.17
NKSZn	56.7	1.49	1.41	2.43	2.43	164.64	42.53	10.29	13.72	174.9	56.3	1.72	1.41	0.82	1.00
NPSZn	46.7	1.31	1.41	2.26	2.43	123.48	42.53	17.15	13.72	140.6	56.3	1.68	1.54	0.78	0.92
NPKSZn	131.7	1.41	1.45	2.43	2.50	172.87	27.44	34.30	10.29	207.2	37.7	1.61	1.54	0.88	0.94
LSD (P=0.01)	1.01	NS	0.10	NS	0.05	4.55	2.11	1.11	1.15	6.22	2.11	NS	0.03	0.01	0.03

BT = Before transplanting, AH = After harvesting.

Quantitatively both the control and PKSZn treated plots showed the minimum number of the algal population (Table 1), but contained higher amount of N in comparison to N treated plot. This possibly suggests the predominance of potentially active hetrocystous N-fixing BGA genera operative in N-deficient plots of control and PKSZn. The later treatment showed about 9.5% more N than the control but about 9.2% less N than the highest content of N in plot receiving 120 kg N/ha. It could be assessed that the performance of N-fixing BGA in rice field ecosystem is very much promising achieving about 91% of total N as compared to that reserved by 120 kg N/ha after harvesting. These findings corroborated well with the observations of other researchers[14-16].

Nevertheless, the significant contribution of BGA can not be overruled if we move across organic matter content of the soil after harvest (Table 1). It is clearly apparent that BGA could decidedly and significantly enriched the soil with biomass which is the vital and key factor to maintain the soil health and thus soil fertility. Higher C . N ratio (0.92 to 1.17) against 0.63 to 1.00 after harvesting the crop ascertained the accumulation of biomass in the soil. It is again interesting to note that the highest C : N ratio (1.17) was osberved in PKSZn treated plot supporting the fact that indigenous BGA grow better in N-deficient soil. Similar views were advanced by Roger and Kulasooriya[3] and Venkataraman[17].

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